Idaho Standard Method of Test for

Vibratory Spring-Load Compaction for Coarse Granular Material

Idaho IT-74-98

Idaho IT-74 is identical to WSDOT Test Method No. 606, "Method of Test for Compaction Control of Granular Materials," with the following exceptions.

A. Delete 1.1b and replace as follows: When Idaho IT-74 is specified as an alternative to AASHTO T 99 or AASHTO T 180, Idaho IT-74 should be used if the material has more than about 10% retained on the 3/4 in. (19 mm) screen.

B. Use of the WSDOT forms included in Test Method No. 606 is optional. ITD forms may be substituted.

WSDOT Test Method T 606
Method of Test for Compaction Control of Granular Materials

1. Scope

a. This test method is used to establish the theoretical maximum density of granular materials and non-granular materials with more than 30% by weight of the original specimen is retained on the No. 4 Sieve or more than 30% by weight of the original specimen is retained on the ¾" sieve.

b. There are three separate tests in this method which present a method for establishing the proper theoretical maximum density values to be used for controlling the compaction of granular materials. These tests account for variations of the maximum obtainable density of a given material for a given compactive effort, due to fluctuations in gradation.

c. By splitting the material on the U.S. No. 4 (4.75 mm) sieve and determining the specific gravity, the compacted density, and the loose density of each of the two fractions, a curve of theoretical maximum density versus percent passing the U.S. No. 4 (4.75 mm) sieve can be plotted. These curve values will correlate closely with the densities obtained in the field; using modern compaction equipment.

d. Table 1 identifies the Test, Method or Procedure to use in performing T 606. The table is divided into the Fraction of the split (Fine or Coarse) and the material type of that Fraction.

Test Method Selection Table	
Fine Material	
Soil Type	**Test Method**
Sandy, Non Plastic, Permeable	T606 Test 1
Silt, Some Plasticity, Low Permeability	T 99 Method A
Sandy Silt, Some Plasticity, Permeable	T 606 Test 1 / T 99 Method A (use higher results)
Coarse Material	
No more than 15% by weight of original aggregate specimen exceeds ¾" (19 mm)	T 606 Test 2 Procedure 1
15% or more by weight of original aggregate specimen is greater than ¾" (19 mm), but does not exceed 3 in. (76 mm)	T 606 Test 2 Procedure 2

Table 1

e. The test methods are applicable either to specifications requiring compacting to a given percentage of theoretical maximum density, or to specifications requiring compaction to a given compaction ratio.

f. Use of these test methods eliminates the danger of applying the wrong "Standard" to

compaction control of gravelly soils.

g. Native soils within the contract limits to be used for embankment construction and/ or backfill material do not require the sampling by a qualified tester. For material that requires gradation testing such as but not limited to manufactured aggregates and Gravel Borrow, a qualified tester shall be required for sampling.

Test No. 1
(Fine Fraction-l00 Percent Passing U.S. No. 4 (4.75 mm) Sieve)

1.1 Scope

a. This test was developed for the sandy, non-plastic, highly permeable soils which normally occur as the fine fraction of granular base course and surfacing materials.

b. When the fine fraction is primarily a soil having some plasticity and low permeability, AASHTO T 99 (Standard Proctor Test) may be used. With borderline soils, both tests should be applied and the one yielding the highest density value should be used.

1.2 Apparatus

a. Vibratory, Spring Load Compactor — Specifications for vibratory spring load compactor can be obtained from the State Materials Lab.

b. Mold — Molds can be fabricated from standard cold drawn-seamless piles or tubes. The dimensions for the small mold are; height 8 in (± 0.002 in), ID 6 in (± 0.002 in). The wall thickness of the mold shall be no less than ¼ in. The mold has a bottom plate which attaches to the mold and is slightly larger than the outer diameter of the mold. The small button at the center of the small mold follower is a measuring point. The height of this button should be adjusted so the machine follower does not bear on it during compaction.

c. Mold Piston — A piston which has a bottom face diameter of 5 ⅞ in (150 mm) OD and an overall height of 2 in. The top of the piston shall have a 2 ¼ in ID.

d. Height-Measuring Device — A scale with an accuracy of 0.01 in (0.25 mm).

e. Tamping Hammer — As specified in AASHTO T 99, Section 2.21.

f. Sieve — U.S. No. 4 (4.75 mm) sieve.

g. Oven — Capable of maintaining a temperature of 230° ± 5°F (110 ± 5° C) for drying moisture specimens.

h. Balance — A balance having a capacity of 100 lbs (45 kg) and a minimum accuracy of 0.1 lbs (50 g).

i. Tamping Rod — ⅝ in (16 mm) spherical end.

1.3 Procedure

a. Oven-dry the total original sample at a temperature not to exceed 140°F (60°C).

b. Obtain tare weight of mold and bottom plate, record weight (mass) to the nearest 0.01 lb (5 g) or less if using a balance that is more accurate than 0.1 lbs.

c. Sieve the entire specimen over a No. 4 (4.75 mm) sieve to separate the fine and coarse material. Retain the coarse material for the second half of the procedure (T 606 Test 2).

d. Split the No. 4 minus material in accordance with WSDOT FOP for AASHTO T 248 to obtain a representative specimen of approximately 13 lbs (6 kg). (This mass can be adjusted after the first compaction run to yield a final compacted specimen approximately 6 in (150 mm) high.)

e. Estimate the optimum moisture for the material. Calculate the mass of water required for optimum moisture and add water to specimen.

Weight of Water

Equation: *Wt. of water = (decimal percent water)(mass dry sample)*

f. Mix the specimen until the water and dry material are thoroughly and completely mixed.

g. Place the specimen in the mold in three layers. Rod each layer 25 times and tamp with 25 blows of the tamping hammer. The blows of the hammer should produce a 12 in (305 mm) free fall provided severe displacement of the specimen does not occur. In such cases, adjust the blow strength to produce maximum compaction. The surface of the top layer should be finished as level as possible.

h. Place the piston on top of the specimen in the mold, and mount the mold on the jack in the compactor. Elevate mold with the jack until the load-spring retainer seats on top of the piston. Apply initial seating load of about 100 lbs (45 kg) on the specimen.

i. Start the compactor hammers and, at the same time, gradually increase the spring load on the specimen to 2,000 lbs (908 kg) by elevating the jack in accordance with Table 2.

j. Check the mold for specimen saturation. The specimen is considered saturated when, free water (a drop or two of water) shows at the base of the mold. If water is not present at the base of the mold within the first 1½ minutes stop the test, remove the specimen from the mold and repeat 1.3 e-j. The specimen can be reused for subsequent water contents providing it is not a fragile material.

k. Caution: Most materials will yield the highest density at the moisture content described

above. Some materials may continue to gain density on increasing the moisture above that specified; however, severe washing-out of the fines will occur, which will alter the character of the sample and void the test results.

l. If moisture is observed at the base of the mold continue applying loads at the following rates:

Load in lbs (kg)	Time in Minutes
100 to 500 lbs (45 to 227)	1
500 lbs to 1,000 lbs (227 to 454)	1/2
1,000 lbs to 2,000 lbs (454 to 908)	1/2

Rate of Load Application
Table 2

m. After reaching 2,000 lbs (908 kg), stop the hammers, release the jack, and return to zero pressure.

n. Repeat step h. four additional times; remove the mold from the compactor.

o. Measure and record the height of the compacted specimen to the nearest 0.01 in (.25 mm) and calculate the volume (see Section 1.4)

p. Remove the specimen from the mold, weigh it, and record its mass (weight) to the nearest 0.01 lbs (5 g), and calculate the wet density.

q. Vertically slice through the center of the specimen, take a representative specimen (at least 1.1 lbs (500 g)) of the materials from one of the cut faces (using the entire specimen is acceptable), weigh immediately, and dry in accordance with AASHTO T 255 to determine the moisture content, and record the results. Calculate and record the dry density.

r. Repeat steps d. through m. at higher or lower moisture contents, on fresh specimen if needed, to obtain the theoretical maximum density value for the material, three tests are usually sufficient.

1.4 Calculations

a. The formula for calculating the volume and dry and wet densities are as follows:

$$V = \frac{(H1-H2)(B)}{1728}$$

Where:

V= Volume, ft^3

H_1= Inside height of the mold, in
H_2= Height from top of the specimen to the top of the mold, in
B = Inside bottom area of the mold, in^2

$$\text{Wet Density (pcf)} = \frac{Wet\ Mass\ (Weight,lbs.)}{Volume\ (cu.ft.)}$$

$$\text{Dry Density (pcf)} = \frac{Wet\ Density\ (pcf)}{1 + Moisture\ Content\ (in\ decimal)*}$$

*Note: See AASHTO T 255-00"Total Moisture Content of Aggregate by Drying," for moisture content calculations.

Test No. 2
(Coarse Fraction-100 Percent Retained on the U.S. No. 4 (4.75 mm) Sieve)

2.1 Scope

a. This test is used when there is 100 percent retained on the U.S. No. 4 (4.75 mm) sieve. There are two separate procedures based on the maximum size of the aggregate being tested. Procedure 1 is used when no more than 15% by weight of the original specimen of the coarse aggregate exceeds ¾ in (19 mm). Procedure 2 is used when 15% or more by weight of the original specimen of the aggregate is greater than ¾ in (19 mm), but does not exceed 3 in (76 mm). If there is any aggregate greater than 3 in (76 mm), it has to be removed before proceeding with the test.

Procedure 1
(Aggregate Size: No. 4 to ¾ in (19 mm)

2.2 Equipment

a. The apparatus for this test is the same as that used in Test No. 1

2.3 Procedure

a. From the coarse split obtained in Test No. 1, Section 1.3(C), separate a representative specimen of 10 to 11 lbs (4.5 to 5 kg) and weigh to 0.01 lbs (5 g), or less if using a balance that is more accurate than 0.1 lbs.

b. Dampen the specimen to 2½% moisture and place it in a 0.1 ft^3 (0.0028 m^3) mold, in three lifts. Tamp each lift lightly to consolidate the material to achieve a level surface. Omit rodding. Avoid loss of the material during placement.

c. Place the piston on top of the specimen in the mold, and mount the mold on the jack in the compactor. Elevate mold with the jack until the load-spring retainer seats on top of the piston. Apply initial seating load of about 100 lbs (45 kg) on the sample.

d. Start the compactor hammers and, at the same time, gradually increase the spring load on the sample to 2,000 lbs (908 kg) by elevating the jack in accordance with the Table 2.

e. Follow procedure described in Test No. 1 Section 1.3 m through 1.3 r.

f. Using the original dry weight value, calculate the dry density in lb/ft^3 (kg/m^3). Use the formula for dry density described in Test No.1, Section 1.4.

Procedure 2
(Aggregate Size: No. 4 to 3 in (76 mm))

2.4 Equipment

a. ½ ft^3 (0.014 m^3) standard aggregate measure.

b. A metal piston having a diameter ⅛ in (3 mm) less than the inside diameter of the ½ ft^3 (0.014 m^3) measure.

2.5 Procedure

a. From the coarse fraction in Test No. 1, Section 1.3c., separate a representative specimen of 45 lbs (20 kg) and weigh to 0.1 1b. (50 g), or less if using a balance that is more accurate than 0.1 lbs.

b. Split the specimen into five representative and approximately equal parts.

c. Place the specimen in the mold in five separate lifts after each lift is placed in the mold, position the piston on the specimen, mount the mold in the compactor, and compact as described in Table 2, Section 1.3h. Spacers between the load spring and piston must be used to adjust the elevation of the mold to the height of the lift being compacted.

d. After the final lift is compacted, remove the mold from the compactor, determine the height of the compacted specimen, and calculate the volume (see Test No. 1, Section 1.4(a)).

e. Calculate the dry density in lbs/ft^3 (kg/m^3) (see Test No. 1, Section 1.4(a)).

Test No. 3
Specific Gravity Determination for Theoretical Maximum Density Test

3.1 Equipment

a. Pycnometer calibrated at the test temperature having a capacity of at least 1 quart (100 ml).

b. One vacuum pump or aspirator (pressure not to exceed 100 mm mercury).

c. One balance accurate to 0.1 g.

3.2 Material

a. Fine fraction U.S. No. 4 (4.75 mm) minus 1.1 lbs (500 g) minimum.

b. Coarse fraction U.S. No. 4 (4.75 mm) plus 2.2 lbs (1,000 g) minimum.

3.3 Procedure

a. Place dry material, either fine or coarse fraction, in pycnometer, add water. Put pycnometer jar top in place and connect to vacuum apparatus. Apply vacuum for at a minimum of 20 minutes until air is removed from specimen. Slight agitation of the jar every 2 to 5 minutes will aid the de-airing process. If the material boils too vigorously, reduce the vacuum. Remove vacuum apparatus, fill pycnometer with water, dry outside of jar carefully and weigh. Water temperature during test should be maintained as close to 68° ± 1° F (20° ± 0.5° C) as possible.

Calculate Specific Gravity as follows:

$$\text{Sp. Gr.} = \frac{a}{a+b-c}$$

Where:

a = Weight of dry material, grams
b = Weight of pycnometer + water, grams
c = Weight of pycnometer + material + water, grams

3.4 Reports

a. All test results are recorded on the theoretical maximum density work sheet.

b. Use the appropriate computer program to determine the theoretical maximum density.